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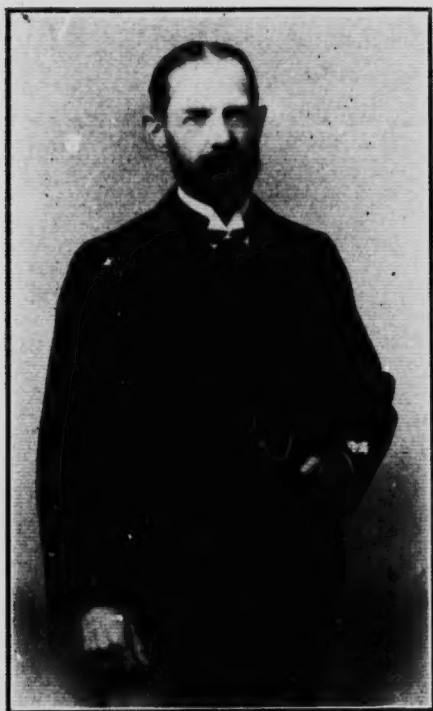
SIR GEORGE HOWARD DARWIN

BY

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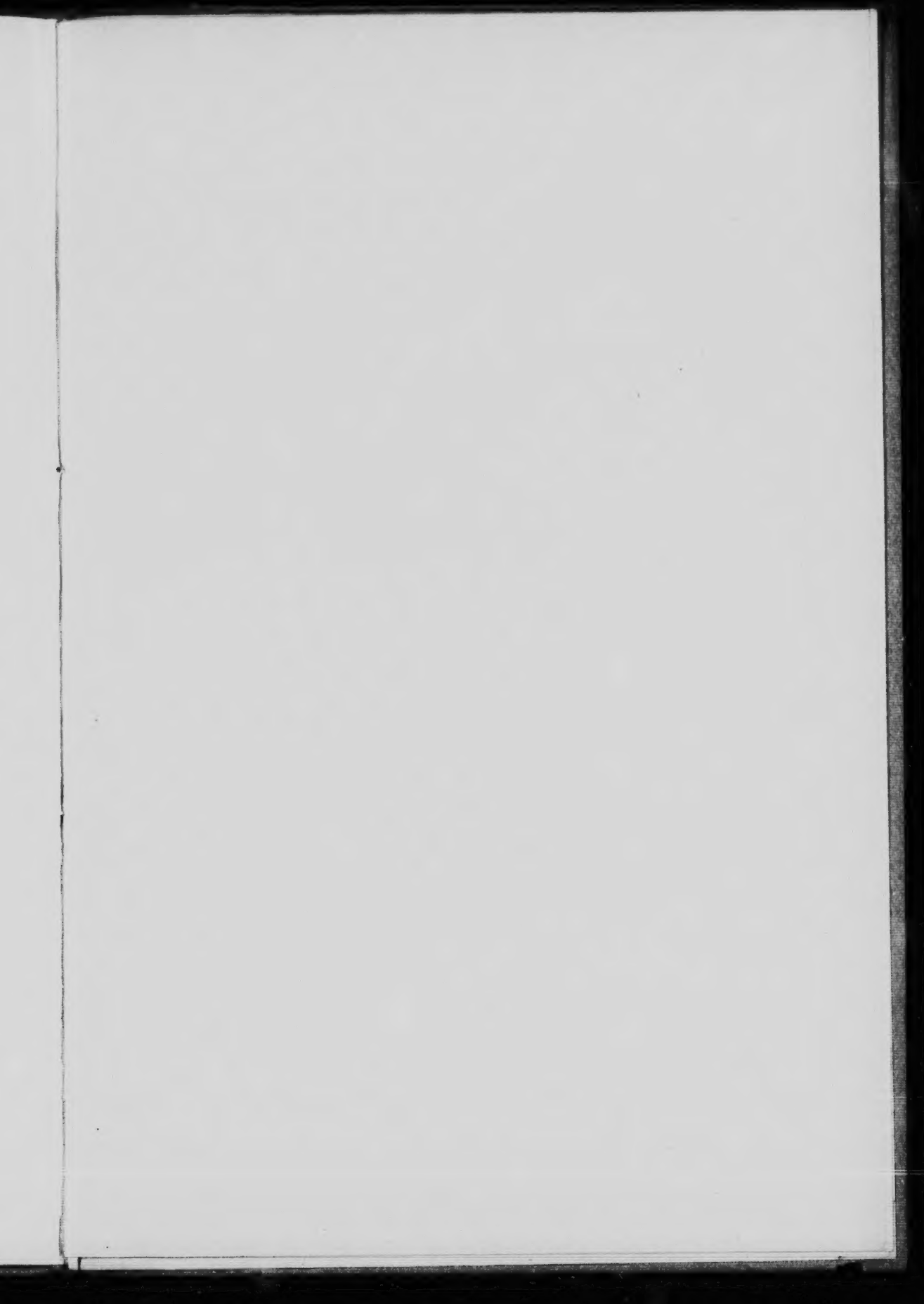
PLATE VIII.



GEORGE HOWARD DARWIN (about 1901)

Born, July 9, 1845. Died, December 7, 1912.

Journal of the Royal Astronomical Society of Canada, 1913



SIR GEORGE HOWARD DARWIN

BY ALFRED T. DELURY

ON December 7 last there passed away Sir George Darwin, one of the ablest astronomers of our day. His original investigations had meant real acquisitions and had quickened astronomical research along certain important lines; his teaching had attracted to his science and stimulated a considerable band of younger writers; and his popular expositions, though too few, had revealed to the many who are interested in astronomy the significance of the discoveries in which he was interested. He had thus become endeared to an unusually large circle, now called upon to mourn the loss to science with an added element of personal grief.

George Howard Darwin was born in 1845 at Down in the County of Kent. He was the second son of Charles Darwin, who in 1842 had chosen to live at Down as affording the quiet necessary to his health and his studies and researches, and the advantage of nearness to London with all its scientific interests and activities. Recalling that his father's great work, "The Origin of Species," was published in 1859, we see that he was born into an atmosphere charged with ideas; and that when at an age at which his mind would naturally be asserting his character, he found himself amid the din and controversy attendant upon a revolution in scientific thought. The influence of these things upon the trend of his development would seem to be manifest.

At school he was a pupil of Charles Pritchard, afterwards Savilian Professor of Astronomy at Oxford, and here his attention may have been given a turn in the direction of mathematics and astronomy. He entered Trinity College, Cambridge, in 1864, and followed the course prescribed for the Mathematical Tripos, being ranked second wrangler on graduation in 1868.

This course, whatever its weaknesses or defects may have been, had the merit of assuring to the student, who followed it seriously and well, a thorough acquaintance with the methods and results of mathematical physics, a knowledge of which was essential to the investigations that were to claim his attention.

Though on making his degree he was appointed to a fellowship in his college, he discontinued his scientific studies, and, like Cayley and Sylvester, turned his attention to the study of law. He was called to the Bar in 1874, but, like them, returned unreservedly to his science. Cambridge again became his home, and in 1883 he was named to the Plumian chair of astronomy and experimental philosophy.

At this time he was well advanced along one of his lines of study, the theory of the tides, a subject which, on account of its incompleteness and difficulty, has made demands on the best energies of nearly all dynamical astronomers. William Thomson, afterwards Lord Kelvin, had sought to apply to the tides a method of analysis similar to that employed in the lunar and planetary theories, and had submitted, in a series of reports to the British Association, the results of the analysis of tidal observations. The work of Kelvin was taken up and continued by Darwin, associated with Adams, and he prepared a number of reports and papers of distinct practical and theoretical value.

Closely related to these studies on actual tides, is a series of investigations on tidal friction and its bearing on cosmogony or cosmic evolution. In one very important paper, "On the Precession of a Viscous Spheroid, and on the Remote History of the Earth," he considers at length the relation of the moon to the earth and states that his speculations "point strongly to the conclusion that, if the moon and the earth were ever molten viscous masses, they once formed parts of a common mass." He further observes that this leads "at once to the inquiry as to how and why the planet broke up. The conditions of stability of rotating masses of fluid are unfortunately unknown, and it is, therefore, impossible to do more than speculate on the subject." Later, as we shall see, he was in a position to extend his investi-

gation still farther back. Throughout this set of papers the guiding purpose was to realize the details of planetary development and to explain the anomalies in the generally accepted theory presented by the solar system. The facts of the solar system are taken as initial conditions, as it were, and the dynamical theory under certain hypotheses is carried back and made to render precise the probable early conditions. In the more extensive memoirs the author gives an illuminating summary and discussion of the results of the investigation. From one of these summaries a few paragraphs may well be quoted:—

"In the following discussion I shall accept the nebular hypothesis in its main outline, and shall examine what modifications are necessitated by the influence of tidal friction.

"From a consideration of numerical data with regard to the solar system and the planetary sub-systems it appears improbable that the planetary orbits have been much enlarged by tidal friction since the origin of the several planets. But it is possible that part of the eccentricities of the planetary orbits is due to this cause.

"From arguments similar to those advanced with regard to the solar system as a whole, it appears unlikely that the satellites of Mars, Jupiter and Saturn originated very much nearer the present surfaces of the planets than we now observe them.

"The numerical data exhibit so striking a difference between the terrestrial system and those of the other planets, that, even apart from the considerations adduced in this and previous papers, we should have grounds for believing that the modes of evolution have been considerably different.

"This series of investigations shows that the difference lies in the genesis of the moon close to the present surface of the planet, and we shall see below that solar tidal friction may be assigned as a reason to explain

how it happened that the terrestrial planet had contracted to nearly its present dimensions before the genesis of a satellite, but that this was not the case with the exterior planets.

"That the interior satellite of Mars revolves with a period of less than a third of its planet's rotation is, perhaps, the most remarkable fact in the solar system. The theory of tidal friction explains this perfectly, and we find that this will be the ultimate fate of all satellites, because the solar tidal friction retards the planetary rotation without directly affecting the satellite's orbital motion.

"From the discussion in this paper it will have been apparent that the earth and moon do actually differ from the other planets in such a way as to permit tidal friction to have been the most important factor in their history."

These detached statements afford an indication of the problems that engaged the attention of Darwin in the papers under consideration.

A kindred series of papers, supplementing the investigations already mentioned, are the memoirs on the figures of equilibrium of a rotating liquid. For a long time the spheroid, had been regarded as the one stable form of equilibrium of a rotating liquid. Jacobi had shown that the changing spheroids, under contraction and increased angular velocity, tended to a limiting form through which they passed into a new series of figures with three unequal axes. The theory halted here, until Poincaré, taking up the study of possible forms, showed that the Jacobian series tended also to a critical stage through which they in turn passed into a new series of pear-shaped figures. This sequence moreover tended to a critical stage in which the smaller stem part of the pear-shaped figure was ripe for a separation from the major part. Poincaré's papers appeared in 1885. Darwin had, from quite a different point of view, been led to entertain a similar view. The results were of first importance

to him for they allowed him to introduce the initial stage necessary to his application of his theory of tidal friction to the earth-moon system. The pear-shaped figure passed to the rupture or separation stage, and from that point onward the way was clearer, though at the outset a series of changes must occur which are quite unknown.

In 1887 Darwin was asked to deliver the Lowell Lectures in Boston and he chose as his subject "The Tides." The substance of these lectures appeared in 1898 in a volume of the same title. In this work, in addition to giving a general account of the nature of tides and tidal observations and predictions, he gives a most lucid account of the theories that have here been described. The treatment combines in almost unequalled degree the popular and the scientific. This and his famous Presidential Address to the British Association have been read and studied by almost everyone interested in astronomy.

As has been indicated, the greater part of Darwin's work, intrinsically valuable as the individual papers are, can be seen to converge on the great problem of cosmic development. At first he accepted with slight reserve the hypothesis of Laplace. His own investigations introduced modifications of the theory based on the hypothesis, but there remained difficulties, dynamical and physical. With open mind, he examined each new suggestion, and one of the most interesting of his papers, "On the Mechanical Conditions of a Swarm of Meteorites and on Theories of Cosmogony," was written to show "that by a certain interpretation of the meteoric theory we may obtain a reconciliation of these two orders of ideas (*i. e.* the nebular and the meteoric theories), and may hold that the origin of stellar and planetary systems is meteoric, while retaining the conception of fluid pressure." The theory advanced by Chamberlin and Moulton, and known as the planetesimal hypothesis, also claimed his attention, and in the new edition of "The Tides" he devotes the greater part of a chapter to a general explanation and examination of this theory.

Darwin's special knowledge, and his interest in actual prac-

tical problems, led to his being named to several important public or international services. He represented the Royal Society on the British Meteorological Council, and on the Indian Survey, and the British Government on the International Geodetic Association. His election to the presidency of the British Association in 1905, and to the presidency of the International Mathematical Congress in 1912, and the award of the Copley Medal for 1911, alike testify to the outstanding place he held in his science.

The meeting of the Mathematical Congress under his presidency was held at Cambridge in August last. His address, though brief, was full of interest and reflected the man,—his genuine modesty in the matter of his own achievements, and the generous recognition of the work of others. Those who knew him well were aware at the time that he was not in his full physical strength, yet few of those present were prepared for the word that came to them in December last. In his death Cambridge lost a distinguished son, and astronomical science one of its foremost investigators, one who, "burdened by a mighty name" had added to that name a new glory.